ON A COLLECTION OF JURASSIC PLANTS FROM BEXHILL, NEAR LISMORE, N.S.W.

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(Plates vii.-viii.)

Introduction.

Mr. John Mitchell, of Waratah, recently forwarded me a large number of fossil plants from New South Wales for determination and description. Amongst them is a small collection of some thirty-five specimens from Bexhill, 6 miles from Lismore along the Lismore-Murwillumbah railway line, and these are described in the present paper. I have to express my indebtedness to Mr. Mitchell for his kindness in giving me the opportunity of examining his collections.

The specimens undoubtedly come from portion of the Clarence Series, and as the number of plant species recorded from this Series is very small, and also as there is not yet complete agreement as to the subdivision and exact correlation of the Series, the present collection is of more than passing interest.

There is no need to go into the history of the classification of the Clarence Series here; Carne has already discussed it at some length.* Suffice it to say that previous to Mr. Carne's examination, it was divided into Lower, Middle, and Upper Clarence Series, the Middle Series being of rather solid, massive sandstones. Mr. Carne, however, reported that he could see no reason for retaining this subdivision, and in the latest geological map of New South Wales the Series is not subdivided, and it is at present regarded as equivalent to the Artesian Series in New South Wales, and the Walloon Series in Queensland. There is certainly a massive, barren sandstone of considerable thickness

* Mem. Geol. Survey N. S. Wales, Geol. No.6. p.26.

in the Clarence Series, as the writer had an opportunity of observing on a recent, very short visit to the Clarence River district. The sandstones, which form very bold outcrops in the Glenreagh district, certainly represent a very marked horizon in the Series, reminding one of the sandstones of the Hawkesbury Series physiographically as well as lithologically, and, having seen them, it is easy to understand the former tendency to correlate them with the Hawkesbury sandstones; there is, however, no sound evidence for such correlation, and it is practically certain that they represent a much higher horizon than the Hawkesbury sandstones. The massive sandstones at Maclean also form a noticeable feature, and may represent the same horizon as those at Glenreagh. My visit was too short to do any field work, but I was particularly struck by these two coarse, massive sandstones.

There is not much doubt that the Clarence Series is of Jurassic age; the upper part certainly is, but some doubt has been expressed regarding the lower portion. Mr. B. Dunstan, Chief Government Geologist of Queensland, in discussing this point with me, has suggested the possibility of the lower portion of the Clarence Series being the equivalent of the Ipswich Series in Queensland, and therefore of Upper Triassic Age. So far, our knowledge of the palæontology does not confirm this suggestion. Carne has stated very definitely that *Tæniopteris Daintrei* (= *T. spatulata*) occurs in the basal part of the Series.* This species has not yet been found in rocks older than Jurassic in Australia, and so, if Carne's observation be correct, little hesitation is felt in placing the whole of the Clarence Series in the Jurassic.

In discussing the correlation of the Lower Mesozoic rocks in Australia,† I could only find record of four species of fossil plants from the Clarence Series, viz.:—*Cladophlebis australis*, *Thinnfeldia odontopteroides*, *Sphenopteris* sp., and *Tæniopteris spatulata* (= *T. Daintrei*). In addition, *Tæniopteris Tenison-Woodsi* had been seen among specimens collected by Mr. B. Dunstan. Mr.

* Carne, *op. cit.*, p.34.

† Proc. Linn. Soc. N. S. Wales, 1918, Vol. xliii., pp.82-86.

Mitchell's collection contains the following eight species which are described below:—

Cladophlebis australis (Morris).
Coniopteris hymenophylloides, var. *australica* Seward.
Microphyllopteris pectinata (Hector).
Cycadites sp.
Taeniopteris spatulata McClelland.
Araucarites cutchensis Feistmantel.
Araucarites (*Podozamites*) *gracilis* Arber sp.
Araucarites (*Podozamites*) sp.

Although none of these species is new, some are new records for Australia, and they afford further evidence of a Jurassic age for the rocks in which they occur. *Coniopteris hymenophylloides* is a very widespread species in Jurassic strata: *Microphyllopteris pectinata* occurs in Jurassic and Cretaceous strata in New Zealand; species of *Cycadites* range from Rhætic to Cretaceous; *Taeniopteris spatulata* has not yet been found in rocks older than Jurassic in Australia, but has been recorded in rocks classed as Rhætic in New Zealand; *Araucarites cutchensis* occurs in (?)Rhætic and Lower Jurassic rocks in New Zealand and Jurassic rocks in India; *Araucarites* (*Podozamites*) *gracilis* occurs in the Jurassic in New Zealand. Thus it will be seen that there is abundant indication that the present collection as a whole represents a flora of Jurassic age.

The complete list of species known from the Clarence Series is now—

FILICALES.

(?)OSMUNDACEÆ.

Cladophlebis australis (Morris).

CYATHEACEÆ.

Coniopteris hymenophylloides, var. *australica* Seward.

THINNFELDIEÆ.

Thinnfeldia odontopteroides (Morris).

GENERA INCERTÆ SEDIS.

Sphenopteris sp.
Microphyllopteris pectinata (Hector).

CYCADOPHYTA.

Cycadites sp.

(?)CYCADOPHYTA.

Taeniopteris spatulata McClelland.

Taeniopteris Tenison-Woodsi Etheridge Junr.

CONIFERALES.

Araucarites cutchensis Feistmantel.

Araucarites (*Podozamites*) *gracilis* Arber.

Araucarites (*Podozamites*) sp.

Description of Specimens.

CONIOPTERIS HYMENOPHYLLOIDES var. AUSTRALICA Seward.

(Plate vii., figs. 2, 3, 4.)

1904. *Coniopteris hymenophylloides* var. *australica* Seward, Rec. Geol. Survey Victoria, Vol. 1, Pt. 3, p. 163, figs. 6–9.

It is not necessary to repeat the full synonymy of the species here, as it has already been given in considerable detail by Seward* and Arber.†

Coniopteris hymenophylloides is a well-known species with a very wide geographical distribution in rocks of Jurassic age, and its description by Seward, based largely on material from Jurassic plant-beds of the Yorkshire Coast, is as follows: "Frond tripinnate; pinnæ linear acuminate, attached to the rachis at a wide angle; the pinnules vary considerably in size and shape, in some forms they have a few broad and rounded lobes, and in others the lamina is deeply dissected into narrow, linear segments. The fertile pinnules bear the sori at the ends of the veins: the lamina is usually much reduced, and in extreme cases the fertile segments agree closely with those of *Thyrsopteris elegans* Kze., or *Dicksonia Berteroana* Hook. The sori are partly enclosed in a cup shaped indusium; the sporangia appear to have an oblique annulus of the cyatheaceous type. The two lowest pinnules of the pinna are often characterised by their unusual shape, the lower half of each pinnule consisting of long, spreading, and *aphlebia*-like lobes."‡

* Rec. Geol. Survey Victoria. i., p. 163.

† N. Zeal. Geol. Survey, Pal. Bull. 6, p. 32.

‡ Seward, *op. cit.*, p. 164.

In *Coniopteris hymenophylloides* there is considerable variation in the fertile pinnules, and the variety *australica* has been instituted for the Victorian examples in which the fertile pinnules are practically of the same form as the sterile. Comparing this variety with the European examples, Seward says: "The fertile pinnæ of the European fern are often characterised by a considerable reduction in the lamina, but in this respect there is not a little variation; in the Victorian specimens the fertile pinnæ are practically identical with the sterile, except in the occurrence of the sori at the tips of the lobes."*

In describing the species from Jurassic rocks in New Zealand, Arber has made an error in comparing the reduced type of fertile pinnule instead of the normal type with the Victorian form. He says: "The more reduced type of fertile pinnule recalls the specimens from the Jurassic of Victoria (Australia) described by Seward as *Coniopteris hymenophylloides* var. *australica*,"† and then quotes Seward's remarks that the fertile and sterile pinnules in the Victorian form are practically identical.

The specimens described here include both sterile and fertile examples, and appear identical with specimens from the Jurassic rocks in Victoria described by Seward. In the fertile specimens, the preservation is not sufficiently good to show details in the sori.

This is, as far as I know, the first record of this species in the Jurassic rocks of New South Wales. It has not yet been found in Queensland, but is of fairly frequent occurrence in the Jurassic of Victoria. In New Zealand it occurs in Lower and Middle Jurassic rocks. The species appears to be confined to Jurassic strata, but there are very similar forms in the Cretaceous.

The only other species of *Coniopteris* so far recorded from the Australian Mesozoic is *C. delicatula* from the Ipswich Series (Triassic) in Queensland, but this is quite distinct from *C. hymenophylloides*. In the Lower Cretaceous of Queensland (Burrum Series) there are numerous sterile examples referred to

* *Loc. cit.*

† N. Z. Geol. Survey, Pal. Bull. 6, p.33.

Sphenopteris erecta which resemble the sterile pinnæ of *Coniopteris hymenophylloides*: it is possible that the two may be identical, but no fertile examples have yet been found in the Burrum form.

Pittman* has recorded the occurrence of a *Sphenopteris* in the Clarence Series, and it may possibly be portion of a *Coniopteris*.

The specimens figured are Nos. L.10, L.26, and L.33 in Mr. Mitchell's collection.

Cladophlebis australis (Morris).

(Plate vii., fig.1).

For full synonymy, *see* Rec. Geol. Survey Victoria, Vol. i., p.171.

"Frond bipinnate, pinnæ oblique. The pinnules are slightly falcate or straight, attached by the whole base and decurrent: apex generally rather acute. Well-defined midrib, usually persisting to apex: secondary veins make an acute angle with the midrib and bifurcate once or twice before reaching the margin; the margin is entire or slightly serrate. Fertile fronds have the pinnules somewhat narrower and inclined to be straighter than the sterile. Sori in two rows parallel to the midrib; the sori are close together and occupy nearly the whole of the under surface; each one is composed of four (rarely five) sporangia."†

This description is based on material from the Ipswich and Walloon Series of Queensland, the latter being, I believe, identical with the Clarence Series of north-eastern New South Wales. This species is of such common occurrence in the Australian Mesozoic strata, and has been frequently discussed at length, so it is not necessary to go into further detail here.

The specimens from Bexhill consist of impressions which show the general outlines clearly, and, in some cases, the venation; none of them represent fertile fronds. They are identical with Queensland and Victorian examples of the species, though perhaps somewhat closer to the former, and not quite so large as the Victorian specimens.

* Ann. Rept. Dept. Mines, N. S. Wales, for 1880, p.244.

† Queensland Geol. Survey, Pub. 257, 1917, p.3.

Evidence which is gradually accumulating tends to confirm the reference of the Australian *Cladophlebis australis* to the family Osmundaceæ. At some localities in the Jurassic (Walloon Series) of south-eastern Queensland, *Cladophlebis australis* is found very closely associated with stems of *Osmundites*, but the two have not yet been found actually connected. In some of the ferruginous sandstones of this Series, plant-remains are very abundant, but there is little variety as regards species, the material being made up almost wholly of *Cladophlebis australis*, *Taeniopteris spatulata*, *Otozamites* spp., and occasional *Osmundites* stems.

The specimen figured is No. L.24 in Mr. Mitchell's collection.

MICROPHYLLOPTERIS PECTINATA (Hector).

(Plate viii., figs. 1, 4).

1886. *Lomarites pectenata*, Hector, Det. Cat. and Guide, N. Zeal. Court, Ind. and Col. Exhibn., p.66, fig.30A (5).

1917. *Microphyllopteris pectinata*, Arber, N. Zeal. Geol. Survey, Pal. Bull. 6, p.40, Pl. 7, figs.3-6, 8 11.

"Frond bipinnate ?; pinnæ 8 cm. or more in length; rachis fairly stout, sometimes grooved, bearing subopposite or alternate small rounded pinnules, about 6 mm. long and up to 5 mm. across. Pinnules somewhat thick. Lateral nerves forking once or twice." (Arber).

Two specimens are referred to this species, representing pinnæ 7 cm. and 9 cm. long respectively. The rachis is stout and the pinnules short, rounded, attached by the whole base, opposite or alternate and apparently thick; they are up to about 7 mm. long and 5 mm. across. No detail of the venation is preserved.

At first sight, these specimens suggest *Thinnfeldia*, but they are unlike any of the hundreds of specimens of that genus which have come under my notice. The pinnules gradually become smaller both towards the base and apex, giving the pinna(?) a somewhat lanceolate outline. In this respect they are unlike the pinnæ of a *Thinnfeldia* such as *T. Feistmantelii*. It might also be suggested that they represent one branch of the dichotomous frond of *Thinnfeldia odontopteroides*, but the fact that the

pinnules are not modified on the inner side towards the base, and also the general appearance of the basal portion do not support such a suggestion.

Little hesitation is felt in referring these specimens to *Microphyllopteris pectinata*, Arber having instituted the genus for fern fronds with small leaflets, his diagnosis of the genus being: "Fronds pinnate, bipinnate, or dichotomously branched: pinnules small or very small, subcircular or ovate, closely set, broadest at the base, and attached by their whole base. Median nerve feeble, breaking up into simple or forked branches not far from the base of the pinnule."*

Microphyllopteris pectinata occurs in the Lower Jurassic and Lower Cretaceous in New Zealand.

The specimens figured are Nos. L.3 and L.1 in Mr. Mitchell's collection.

(?)Cycadites sp.
(Plate vii., fig.5).

A few specimens may be tentatively referred to this genus. They represent portions of fronds up to 5 cm. in width. The rachis has a breadth of about 2 mm.; the pinnæ are elongate, acute, with the lower edge slightly decurrent at the base; they are about 3 cm. long and 1·5 mm. wide, set close together (about 1 mm. apart) and almost at right angles to the rachis. There is a somewhat indistinct midrib which is, in some cases, broad, and its appearance then suggests the double vein of *Cycadites*.† There is no possibility of obtaining details of the epidermis in these specimens.

The general form in these examples as seen in Plate vii., fig.5, is similar to that of *Cycadites* and *Pseudocycas* (e.g., *Pseudocycas insignis*‡ from the Lias of Hör, Sweden, and *Cycadites* sp.,§ from the Middle Jurassic of Waikawa, New Zealand). There is also some resemblance to specimens from Queensland referred to

* N.Z. Geol. Survey, Pal. Bull. 6, p.40.
† *See* Seward, Fossil Plants, Vol. iii., 1917, pp.558-562.
‡ Seward, *op. cit.*, fig.617.
§ N. Z. Geol. Survey, Pal. Bull. 6, fig.10, facing p.32.

Elatocladus (*Taxites*), but in the present examples there is more regularity in the arrangement of the pinnæ, which suggests that they were not spirally arranged as in *Elatocladus*.

The specimen figured is No. L.27 in Mr. Mitchell's collection.

TENIOPTERIS SPATULATA McClelland (= *T. Daintreei* McCoy). (Plate viii., fig.3).

This species has recently been described and discussed both by the writer* and by Arber,† and it is not necessary to discuss it further. Typical examples of it are amongst the examples from Bexhill, and one is figured.

Taeniopteris spatulata in Australia is of very common occurrence in Jurassic strata, and also occurs sparingly in the Cretaceous; it has not yet been found in the Australian Triassic, though Arber has recorded it from strata which he classed as Rhætic in New Zealand.

The specimen figured is No. L.28 in Mr. Mitchell's collection.

ARAUCARITES CUTCHENSIS Feistmantel. (Plate viii., fig.5[A]).

1876. *Araucarites cutchensis*, Feistmantel, Foss. Fl. Gondwana System, Vol. ii., Pt.1, p.62, Pl. vii., fig.7; Pl. viii., figs.2-6; Pl. ix., figs.1-3; Pl. xii., fig.10.

1877. *Araucarites cutchensis*, Feistmantel, *ibid.*, Vol. ii., Pt. ii., p.16 (96), Pl. xiv.

1879. *Araucarites cutchensis*, Feistmantel, *ibid.*, Vol. i., Pt. iv., p.27 (217), Pl. xiv., figs.6-9; Pl. xv., fig.1; Pl. xvi., fig.15.

1917. *Araucarites cutchensis*, Arber, N. Zeal. Geol. Survey, Pal. Bull. 6. p.56, Pl. viii., fig.5; Pl. xiii., fig.4.

"Seed-bearing scales of the Araucarian type. Scales more or less broadly wedge shaped, the base narrow, truncated, the apex broad; rounded, or truncated, often produced as a median, narrow, linear appendage. Seed single, ovoid, the broader extremity being towards the apex of the scale." (Arber).

A single specimen of an Araucarian seed-bearing scale seems

* Queensland Geol. Survey, Pub. 257, p.30.

† N. Z. Geol. Survey, Pal. Bull. 6, p.46.

identical with Feistmantel's species *A. cutchensis*. It is about 13 mm. long and is 11 mm. wide at the top and 3 mm. at the base; there is no apical spine, though one may have been present. The depression occupied by the seed shows quite distinctly and is about 8 mm. long and 3 mm. broad at the widest part; its broader end is towards the apex of the scale.

The specimen is very similar to those described from Rhætic and (?)Lower Jurassic rocks in New Zealand and also from the Jurassic of India.

Two types of scale have been figured from the Jurassic of Victoria by Seward as *Araucarites* sp.A, and *Araucarites* sp.B, but both are rather different from the present example. From the Lower Cretaceous (Burrum Series) in Queensland, scales have also been described as *Araucarites Arberi*,* but they also are rather different from the Bexhill specimen.

In view of my description recently of a fragment of an Araucarian cone† borne on a stem to which were attached leaves of the *Podozamites* type, it is interesting to note that the present scale occurs in association with examples of *Podozamites*. Evidence is thus tending to show that the leaves we refer to *Podozamites* in Australia are coniferous, and it would give a better idea of their affinities if they were designated *Araucarites* (*Podozamites*).

The specimen figured is No. L.14 in Mr. Mitchell's collection.

ARAUCARITES (PODOZAMITES) GRACILIS Arber.

(Plate viii., fig.2).

1917. *Podozamites gracilis*, Arber, N. Z. Geol. Survey, Pal. Bull. 6, p.54, figs.11, 12.

"Shoots exceeding 20 cm. in length. Leaves spirally arranged, linear-lanceolate, up to 6 cm. in length, and 4 mm. to 5 mm. broad at their greatest width. Base gradually contracted but not decurrent, apex acuminate. Nerves about 5 to 7 in number, parallel." (Arber).

* Queensland Geol. Survey, Pub. 263, p.40.

† Queensland Geol. Survey, Pub. 262, p.11.

A number of our specimens may be referred to this New Zealand species which, as Arber points out, differs from *Podozamites lanceolatus* in having narrower and more linear leaves. *P. gracilis* occurs in New Zealand in rocks referred by Arber to the Middle Jurassic.

The specimen figured is No. L.12 in Mr. Mitchell's collection.

Araucarites (Podozamites) sp.
(Plate viii., fig.5[B]).

There are a few examples in the collection in which the leaves are even more slender and much farther apart than in those I have referred to *P. gracilis*. The leaves are about 5 cm. long and 2 to 3 mm. wide, with about five parallel veins.

The material is hardly sufficient to warrant specific identity, and it is possible that it may represent only a variation of *Araucarites (Podozamites) gracilis*; for the present it may be noted as *Araucarites (Podozamites)* sp.

The specimen figured is No. L.14 in Mr. Mitchell's collection.

EXPLANATION OF PLATES VII.-VIII.

(All figures approximately natural size.).

Plate vii.

Fig.1.—*Cladophlebis australis* (Morris).

Fig.2.—*Coniopteris hymenophylloides*, var. *australica* Seward. Fertile frond.

Fig.3.—*Coniopteris hymenophylloides*, var. *australica* Seward. Sterile frond.

Fig.4.—*Coniopteris hymenophylloides*, var. *australica* Seward. Part of fertile frond.

Fig.5.—*Cycadites* sp.

Plate viii.

Fig.1.—*Microphyllopteris pectinata* (Hector).

Fig.2.—*Araucarites (Podozamites) gracilis* Arber.

Fig.3.—*Tæniopteris spatulata* McClelland.

Fig.4.—*Microphyllopteris pectinata* (Hector).

Fig.5. { A. *Araucarites cutchensis* Feistmantel.
B. *Araucarites (Podozamites)* sp.

Locality: Bexhill, 6 miles from Lismore, N.S.W.